**Concave Mirror Optical Bench Laboratory**

Objective: To observe the different types of images that can be formed by concave mirrors. To determine a relationship between image distance and object distance for the concave mirror

Materials: optical bench, concave mirror, white paper screen, illuminated object.

1. Observing the five cases of image formation with a concave mirror.

    a. Determine the focal length of your mirror. To find the focal point of your mirror, use the mirror to find the image of a distant object on a screen. The distance from the mirror to the screen is your experimental focal point. Do this for three different distant objects.

| | Trial 1 Focal Length (cm) | Trial 2 Focal Length (cm) | Trial 3 Focal Length (cm) | Best Estimate Focal Length (cm) (mean± ½ range) |
|---|---|---|---|---|
| Image Distance for far away object | | | | |

        i. Record the image distance for each object to the **nearest millimeter**. Compute the mean and state your best estimate for the focal length using . You will use this for your experimental focal point using mean ± ½ range.

    b. For each case (object distances of 3F, 3.5F, 2F, 2.5 F, 1.5F, F, 0.5F), you will do the following:

        i. Record object distance (distance of the light bulb from the mirror) and the object height.

        ii. Use the white cardboard screen. Start at the mirror and slowly move away until you see a clear image. You will have to tilt the mirror slightly so the cardboard does not block all the light.

        iii. Once you get the sharpest possible image of the object on the screen, record the image distance (distance of the screen from the mirror). If you cannot get an image on the screen, look for a virtual image in the mirror.

        iv. Measure and record image height. By convention, inverted images have negative image height, upright images have positive image height.

        v. Calculate the magnification by dividing the image height by the object height.

        vi. Record the image characteristics (upside down or upright, magnified or reduced, real or virtual).

vii. Record all measurements to the nearest millimeter.

Data Table

| Case | Object Distance (cm) | Image Distance (cm) | Object height (cm) | Image Height (cm) | Magnification (image height divided by object height) | Image Characteristics (real/virtual, upright/inverted, larger/smaller/same size) |
|---|---|---|---|---|---|---|
| 3F | | | | | | |
| 3.5F | | | | | | |
| 2.5F | | | | | | |
| 2F | | | | | | |
| 1.5F | | | | | | |
| F | | | | | | |
| 0.5F | | | | | | |

1. The mirror equation, $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$, applies to both convex and concave mirrors. By convention, signs are applied as follows:

| Quantity | Positive (+) when: | Negative (-) when: |
|---|---|---|
| **Focal length, f** | **Converging mirror (concave)** | **Diverging mirror (convex)** |
| **Image distance, $d_i$** | **Real image** | **Virtual image** |
| **Image height** | **Image is upright (and virtual)** | **Image is inverted (and real)** |
| **Magnification** $M = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$ | **Image is upright** | **Image is inverted** |

The results of calculations can also be used to predict image position and characteristics!

Use your measured mean focal length and measured object distance, calculate the image distance predicted by the mirror equation for each of the five cases. Then calculate the magnification using image and object distance. Show your work. Be careful of your signs! Refer to the table of sign rules.

1. Object at 3F

**Calculated $d_i$ = _____ Calculated M = _____**

2. Object at 2F

**Calculated $d_i$ = _____ Calculated M = _____**

3. Object at 1.5F

**Calculated $d_i$ = _____ Calculated M = _____**

4. Object at F

**Calculated $d_i$ = _____ Calculated M = _____**

5. Object at 0.5F

**Calculated $d_i$ = _____ Calculated M = _____**

How do your calculations compare to your observations/measurements in this laboratory? Is the mirror equation an accurate way to predict image locations and characteristics? Explain.

**Convex Mirror**

1. The images from a convex mirror cannot be seen on a screen. Why?

2. What are the characteristics of images formed by convex mirrors?

3. Devise a method to determine the focal length of the convex mirror. Make multiple measurements and take an average. Describe your procedure and show your calculations below.

4. Is your focal length reasonable? Explain why or why not.